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AGRICULTURAL

Science Review

COOPERATIVE STATE RESEARCH SERVICE U.S. DEPARTMENT OF AGRICULTURE VOL. 7 NO. 3

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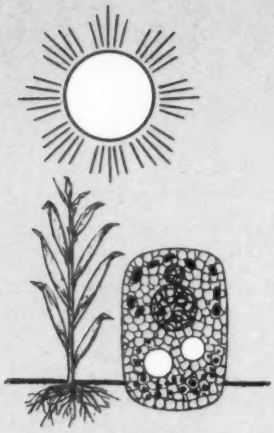

AGRICULTURAL SCIENCE REVIEW

Third Quarter 1969 Vol. 7 No. 3

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Nutritionists, Speak Up!

Author Leo Polopolus makes a good point in his lead article in this issue of *Review*.

"The history of product prohibition," he says, "and legal harassment of substitute food products over the past half-century only serves to emphasize the weakness of this approach as a primary vehicle to thwart competitive products."

Obviously, consumers need the advantages of legal safeguards when a food or food additive is found to be harmful. But the succession of events in the cyclamate story over the past few months illustrates very well the fact that synthetic and substitute foods are well-entrenched. When research reveals shortcomings that may affect the health and welfare of consumers, technological ingenuity seems to find a way to eliminate the hazard, yet continue to offer a substitute product.

No way has yet been found, however, to influence consumer decisionmaking where good nutrition—not safety—is the issue. Thus, a doughnut and a cup of coffee becomes a typical breakfast for millions of Americans, even though we know better. A sure way to set up a rejection syndrome in a child is to tell him that a certain food is "good for you."

It seems ironic that much of the information we need to enable us to maintain sound bodies and clear minds is already in our knowledge banks. But not enough of it is withdrawn and put to use. How many people know, for example, that sugar is an essential ingredient of many foods for reasons other that sweetness? Or that weight control is a matter of caloric input? Or that so-called brain foods are a myth? We would assume, of course, that the readers of this magazine are quite knowledgeable about such matters. But the issue is much more pertinent to a far larger audience than this journal can reach.

Are we faced, then, with untapped opportunities for a bit of solid consumer education?—W. W. K.

Cover: A Court Banquet
(From a woodcut by Schatzbehalter; circa, 1491)

AGRICULTURAL SCIENCE REVIEW is published quarterly by the Cooperative State Research Service, U.S. Department of Agriculture, Washington, D.C. 20250.

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SYNTHETIC AND SUBSTITUTE FOODS

Domestic and International Aspects

LEO POLOPOLUS

MAN'S attempts to devise substitutes for things in his material world cannot properly be considered as unique to our modern era. Although we seem to be living more and more in a world of synthetics and substitutes, our ingenuities along these lines date back to the earliest recorded history. Whether prompted by curiosity, convenience, economy, or necessity, man has, at various times, attempted to substitute one thing for another: fiber garments for skins, metal for wood, domestic animals for wild ones, tractors for draft horses—to name a few.

In recent years, advances in science and technology have opened up new opportunities for devising substitutes in a wide range of manufacturing endeavor. The food industry is no exception. Man's ingenuity with the test tube, for example, has produced food that is far removed from the process of photosynthesis. As a result, a new market situation is emerging that involves practically every segment of agriculture—researchers, producers, and processors. Not the least affected, of course, are the consumers—the final arbiters of the characteristics that food must have if it is to be marketed successfully.

In the industrialized Western world the quest of science, technology, and business is toward the manufacture of new food products that complement and reinforce the corporate objectives of profit and growth. In the developing and underdeveloped countries, however, the problem is largely one of providing adequate sources of protein and other food ingredients to maintain minimum standards of health and nutrition. Unconventional foods are increasingly becoming recognized as items to fulfill nutritional deficiencies and to prevent imbalances in the food supply in relation to population.

This paper presents a review of the major domestic and international aspects of the actual and potential proliferation of synthetic and substitute foods. Research implications for the agriculturally oriented public institutions are also presented.

DEFINITION OF TERMS

SYNTHETIC products are defined as those that include at least one major ingredient derived from nonfarm sources. A major nonfarm ingredient is any substance that displaces natural agricultural materials in a food product's set of basic attributes, particularly flavor, texture, viscosity, and color. Products with synthetic emulsifiers, gases, stabilizers, or other additives that prolong shelf life or permit unique packaging features are not considered to be sufficiently synthetic. Usually petroleum provides the bulk of material for synthetic ingredients.

Substitute food products include one or more major ingredients derived from unconventional agricultural sources. It is assumed that, at a given point

in time, the American society determines whether an ingredient is conventional or not by its purchase behavior. For example, a mock ham produced from soybeans would be regarded as a substitute agricultural product. Generally, the production of a substitute food may utilize different sets of farm resources, often located in different regions of the country.

SCOPE OF THE PROBLEM

IN the domestic market one can grasp the significance of the problem by reviewing recent changes in growth rates, market shares, and prices of both natural and synthetic products. Although data are not available on the scope of synthetic food production alone, the market value of all synthetics (both food and fiber) replacing farm products is approximately 10 percent of the current market value of agricultural production. Moreover, it is believed that the current market value of agricultural substitutes is considerably larger than the value for synthetics, but unfortunately precise figures are unavailable.

Because of inadequate aggregative data, the size and effect of synthetics and substitutes can be viewed more clearly from an inspection of individual industry situations. The dairy industry, for example, would have to be about 25 percent larger than it is today if it had not lost some of its markets for certain dairy products. In 1955 substitutes and synthetics were virtually unknown in the fruit beverage market. Today substitute and synthetic fruit drinks take a 30-percent bite out of an annual $1 billion market.

From 1958 to 1965, synthetic (noncaloric) sweeteners showed an annual growth rate of 9.3 percent as compared with 1.6 percent for agricultural sweetners. The market share of the noncaloric sweeteners, however, is still a relatively small percentage of total sweetener consumption or slightly over 6 percent in 1967.

Although meats seem to be the least affected by the inroads of synthetics, the use of substitutes (plant-based proteins) is increasing. Industry sources estimate that production of soy protein and grits to replace animal-source raw materials totals about 175 million pounds annually. Cereal products annually use about 90 million pounds of soy flour and grits. Sales of simulated meat products made from spun soy isolates are estimated at about $3 million annually.

And so the trend continues in the domestic market. For most synthetic and substitute foods, continued proliferation seems likely. Use of substituted agricultural products, of course, merely transfers the market from one commodity to another. The net effect on either market depends on the size and location of the transfer. In several instances the effects have been quite noticeable—as in some dairy products; in others, the effects are difficult to assess.

On the international scene the development of food analogs involves a much wider range of raw material sources than is the case with synthetics and agricultural substitutes in the domestic market. In addition to the development of prototype food products utilizing the basic commodities of traditional agriculture, three other major sources of raw materials for human food are at least in the experimental stage—marine life (both plant and animal), petroleum, and unconventional plant materials. There are, of course, other unusual approaches to feeding the undernourished, such as increased insect production or the processing of wool or other inedible substances into edible protein.

Although researchers show considerable ingenuity in developing new food products from novel sources, the problem of economic feasibility has limited commercial introduction of these products in both the developing and underdeveloped countries. Because of several factors, such as relatively higher prices of food analogs in relation to traditional foods, rigid local food habits and custom and subsistence or low income levels, new food product introductions designed to improve nutrition are unlikely to become acceptable to consumers in developing nations without subsidy and extensive educational effort. Thus, in a poverty setting a wide gap stands between the design of nutritional products from unconventional sources and product use. In the U.S. market, however, consumers have become increasingly willing to try new food products. Food expenditures take a decreasing percentage of spendable income, and food processors are able to introduce competitively priced substitute and synthetic foods. From the consumer's viewpoint, then, the problem in the domestic market is one of quality and serving convenience. But from the viewpoint of the agricultural industry, the major problems are the impact of food substitutes on resource adjustments and the influence of synthetics on the reallocation of resources

between the agricultural and nonagricultural sectors of the economy.

FACTORS AFFECTING PROLIFERATION

AFFLUENCE is the overriding factor that has permitted the proliferation of thousands of new food products in the United States in recent years. This development appears even more remarkable in view of the relatively low income elasticity for food and the presumably mundane economic environment for food products in the aggregate. Economists have consistently estimated the retail demand for food to be highly inelastic. This suggests that a one percent increase in disposable personal income increases food expenditures by much less than one percent. The traditional argument has been that the growth of the aggregate food market is linked more closely to population growth than to income growth. But the available evidence since World War II, although not contradicting the longstanding economic theory, points up the need for more careful evaluation of the demand for service and convenience factors related to food purchase behavior. Imaginative and resourceful entrepreneurs in food businesses have competed for the increasing wealth of the American economic system by product and service proliferation. It is within this environment of competition that synthetic and substitute food products have penetrated the market.

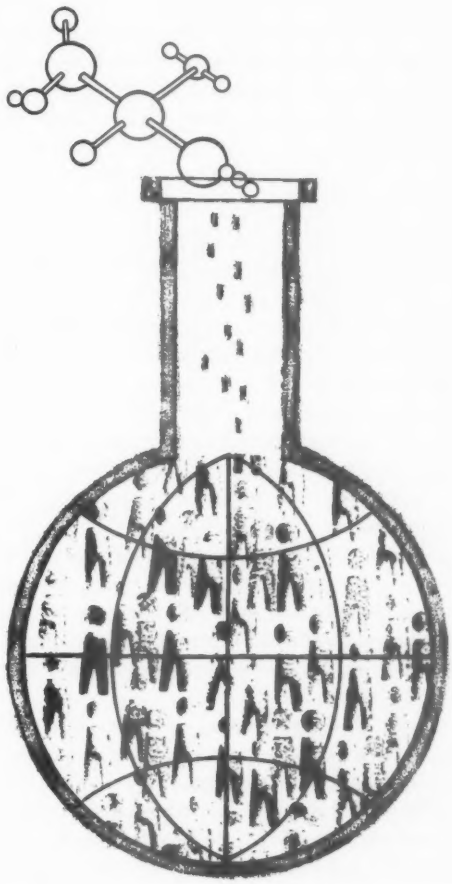
In a more detailed sense, several important factors have contributed to the emergence of substitute and synthetic food products: the vagaries and instabilities of traditional raw product supplies, nutrition and health, religion and custom, vulnerability of protective regulations, and marketing expertise, and, in some cases, better qualities and functional properties of the substitutes.

Vagaries and Instabilities of Raw Products

AGRICULTURAL production is inherently seasonal. Perishability limits the adaptability of some agricultural products to certain types of processing. Freezes, storms, and other acts of nature lead to unstable supplies on either a regional or national basis. Insects and diseases often affect the quality or supply of agricultural commodities.

These problems are well known within the agricultural community and have long been the object of scientific research effort. The private sector has also attempted to nullify or moderate the effects of natural variations in the quality and supply of agricultural commodities for processing. Arrangements to shorten the processing season, lengthen the season or level out the inflow of raw product deliveries within a given season are commonplace in agriculture. Forward contracts or grower-processor contracts have resulted from efforts to control the seasonal span and variation in day-by-day deliveries, as well as to assure adequate total supplies to the processor.

Despite these efforts, instability of supplies in local, regional, and national agricultural commodity markets persists because of random and uncontrollable events. In striking contrast, the users of



synthetically derived ingredients in the manufacture of foods are not adversely affected by the seasonality, perishability, and unpredictable quality of raw products.

A classic example of the introduction of synthetic food products because of the instability of traditional supplies comes from the experiences of the Florida citrus industry. Winter freezes may randomly but abruptly reduce production and increase prices of natural citrus juices. Shortages of natural product and high prices lead to the sales expansion of competitive noncitrus juices and the development of substitute and synthetic citrus drinks.

Florida freezes in the 1950's and 1960's undoubtedly hastened the introduction of substitute drinks containing synthetically-flavored orange powder and no natural fruit solids. Relatively small Florida orange production in the 1967–68 and 1968–69 seasons spurred additional substitute and synthetic product development. For the entire 1967–68 season (December through November), synthetic and substitute orange drinks accounted for approximately one-fourth of the total orange-flavored fruit beverage market.

Nutrition and Health

NUMEROUS agricultural industries have prided themselves for the exceptional nutritional and health qualities of their products. What has anguished many agriculturalists, however, has been the ability of the chemical industry to synthesize a considerable number of vitamins and other food additives from petrochemical sources at a relatively low cost. The overall impact of synthesized food additives upon traditional agriculture has been sizeable, but there has been no attempt to quantify these phenomena.

National health consciousness can become sufficiently aroused regarding certain classes of products to cause dramatic shifts in consumer allegiance. The long term substitution of margarine for butter has been hastened in recent years, for example, by public awareness of cholesterol.

Health defects of food products are quickly illuminated and advertised by competitors supplying substitute or synthetic products. From the public welfare point of view, the research regarding the nature and magnitude of a product's health defects is usually inadequate to support the competitor's inferences and allegations. The implication that butterfat is correlated to heart disease or arteriosclerosis is a case in point. Some medical researchers believe that the dominant conditions associated with the incidence of arteriosclerosis are heredity factors, age, and overweight caused by over-nutrition. It is possible that more importance should be attached to total calorie intake than to dietary patterns or composition.

In the case of the sugar-sweetener competition, the initial stages of the battle centered primarily on price considerations and diet consciousness. Both saccharin and cyclamates are considerably cheaper than sugar for a given amount of sweetness, and had been promoted extensively on the theme of weight control. The natural sugar industry has recently countered with allegations that excessive use of cyclamates could prove harmful to human health, particularly among children.

Health and nutrition factors need to be distinguished when analyzing the impact of substitute and synthetic food products upon traditional agricultural markets. It clearly appears as though the basic vitamins and minerals required daily by humans can be easily and cheaply manufactured from synthetic or nonagricultural sources. The overall health properties of various food products—natural, substitute, or synthetic—have not, however, been adequately and sufficiently established by competent and impartial research agencies. Additional comments relating to health and nutrition research appear in a later section of the paper.

Religion and Custom

It is normally assumed that religion and ancestral, regional, and national custom have a pronounced effect upon dietary habits and, consequently, upon the willingness of consumers to experiment with substitutes and synthetics. The rapid development of substitute and synthetic food products in recent years suggests, however, that religion and custom in the United States do not seriously inhibit the switching of food components in normal diets. There is, of course, the national tradition of turkey and cranberries on Thanksgiving and Christmas or boiled eggs on Easter, but these are largely symbolic and susceptible to numerous substitutions. Particular regions are known for special dishes, such as tacos in the Southwest or grits in the South.

THE ban on the use of cyclamate artificial sweeteners, which was announced after the accompanying article was written, came partly as a result of research questions raised about all synthetic sweeteners nearly eight years ago by the Food and Nutrition Board of the National Academy of Sciences-National Research Council.

Other research problem areas posed by this 1962 policy statement of NAS–NRC have apparently been overshadowed by the ensuing emphasis on the possible dangers of cyclamates, as evidenced by this excerpt from the NAS–NRC report:

"There is no clear justification for the use of artificial sweeteners by the general public as a weight reducing procedure, even though sweet-tasting food is recognized as giving a psychological 'lift' to many individuals, and even though the substitution of a non-nutritive sweetener for sugars does decrease the caloric content of foods in question. It is emphasized strongly that the availability and consumption of artificially sweetened foodstuffs have no direct influence on body weight, nor are the foodstuffs in question of any importance in weight reducing programs except as they are used in feeding regimens in which the total energy intake is supervised and controlled."

Even as early as 1956, research findings had been documented which raised serious questions as to the usefulness of synthetic sweeteners to control obesity. A Harvard nutrition research group, in a report published in the April 1956 *Journal of the American Dietetic Association*, summarized their work as follows:

"No significant difference was apparent when the weight loss of users and non-users of these products (non-caloric sweeteners and artificially sweetened foods) was compared. No correlation was found between the length of time these products were used and weight loss, nor was the degree of overweight associated with the use of these products . . . The products were generally not too popular among obese individuals. There was a higher degree of acceptability among the diabetic subjects."

Regional foods, as well as foreign foods, are becoming standard items throughout the United States as affluence, mass marketing, and effective communications increase. In fact, it is man's interest in food variety that is characteristic and fundamental to the proliferation of substitute and synthetic foods.

There are, of course, minor subgroups of the populace that cling to more restricted diets, usually because of religion. For example, the development of simulated meat protein products from edible spun-soy protein has been encouraged and sponsored by the Seventh-Day Adventists Church. Members of this church have historically accounted for the bulk of the simulated meat product market. Soybeans provide the raw material for these products, which include mock beef, chicken, ham, bacon, turkey, and shrimp. There are other subgroups of the population that practice vegetarianism, abstain from eating pork, or refuse to consume processed or inorganically produced products. This latter group, the organic health food addicts, prefer not to consume any product that has been produced with chemicals (e.g., fertilizers and herbicides) or processed with additives. Although these various subgroups provide interesting examples, they do not, in an aggregate sense, comprise a significant component of the U.S. food market. They do, however, provide a basis for developing a different style and approach to food, particularly with regard to meat substitutes.

Protective Regulations

LEGAL prohibition is one method of restricting the introduction and penetration of rival substitute and synthetic products. Another method is to require by law that a substitute or synthetic product be manufactured in a particular form, color, or package that distinguishes it from the original product. General laws to protect consumers from deception and fraud also provide some form of protection.

The history of product prohibition and legal harassment of substitute food products over the past half-century only serves to emphasize the weakness of this approach as a primary vehicle to thwart competitive products. The dairy industry serves as a useful example. State legislation to restrict the sale of margarine has been a useless experiment in regula-

tion and control. Some states legally defined margarine, prohibited the use of certain oils in the manufacture of margarine, outlawed yellow margarine or required that it be colored pink. Even the Federal government imposed taxes on margarine between 1902 and 1950. But despite these efforts, per capita margarine consumption has increased from 2 pounds in the early 1920's to about 10 pounds presently, while per capita butter consumption has dropped from 18 pounds to about 6 pounds over the same period.

There is considerable ambiguity in public policy relating to food product standards. In some cases Federal statutes require that the U.S. Department of Agriculture provide inspection and regulation to insure the safety and grade of certain products marketed in interstate commerce. In other instances, food products come under the general product identity and other standards and regulations of the Food and Drug Administration. And despite congressional enactment of a "truth-in-packaging" bill, there is no coordinated program to insure that consumers are reasonably protected from deceptive and fradulent packaging, labeling, and advertising practices.

On the one hand, there is a public need for protecting the consumers' health and welfare. But there is also a need to safeguard the public from over-regulation of certain products merely to protect the vested positions of competitive producers.

Marketing Expertise

EXCEPT for the general condition of affluence, marketing sophistication or expertise is the most important factor contributing to the proliferation of synthetic and substitute foods in the United States. The term expertise is defined in this context as the ability of marketers to fulfill consumer wants by product variation or market segmentation or both.

Deficiencies in existing food products are often revealed to food manufacturers from extensive market tests with consumers. Product development of this type suggests that the marketing departments of food firms are as closely linked to product development as the research and technical departments. The marketing department usually spells out rather complete product specifications in advance of development work. Natural or existing products may be viewed as unsatisfactory products to consumers because of various product properties, including flavor, nutrition, viscosity, color, uniformity, and serving convenience. Synthetic and substitute food manufacturers attempt to capitalize upon those deficiencies by drawing upon raw materials that circumvent the deficiencies or generally improve the product. In this process the manufacturer is not particularly concerned about the nature of the raw materials—natural, substitute, or synthetic.

Since the manufacturer is profit motivated, he will readily abandon the relatively high-priced raw materials. Differences in raw material costs are sub-

stantial, for example, between natural frozen concentrated orange juice and imitation frozen concentrated orange drinks. The same can be said of the cost differences between whole fluid milk and filled milk. Unfortunately for natural product producers, their raw products are usually higher priced, and hence, substituted away. Cost differences between traditional and substitute or synthetic ingredients are significant not only in terms of establishing a high gross margin, but in providing considerable opportunity for massive promotional campaigns. Even if the advertising response is negligible, the difference between manufactured product cost and f.o.b. selling price for synthetic and substitute products is sufficiently large to permit price reductions or other price strategies.

WORLDWIDE ASPECTS

MUCH has been written about the world population-food problem, and the relevant data have been so widely publicized that there is no need to repeat them here. It will suffice to say that the impending collision between population and food supply may well be the biggest problem ever to confront the human race. Only about one-third of the world—the economically advanced countries—can be assured an adequate food supply from conventional agriculture. In the remaining two-thirds, population is increasing at the rate of 1 million people per week and malnutrition is widespread. The situation has produced three schools of thought: (a) that the crisis can be averted only by strict population control, (b) that we must rely mainly on stepped-up programs of conventional agriculture, and (c) that the crisis can be met by making more nonagricultural foods available—in other words, synthetic and substitute foods. As might be expected, the proponents of all three groups have adopted vigorous action programs, and some philosophical observers contend that all three concepts will eventually be needed to cope with the crisis.

Unconventional Food Sources

WHILE affluence in the domestic consumer market has contributed largely to the development of new and varied forms of conventional foods, a different set of factors is contributing to the sharply stepped-up activity in the development of food from unconventional sources. Underlying all causes is the fact that, on a worldwide basis, conventional agriculture is not supplying sufficient calories and protein for proper nutrition. Certain social and economic restraints also inhibit food production in underdeveloped countries. As one example, consider the fact that although one-third of the world's cattle population is in Africa and India, most of these animals are not utilized fully—partly because of religious and social customs. Inevitably, the situation will change. But until it does, other food sources must be found.

Fish Products.—Although early efforts to produce a fish protein concentrate (FPC) suffered many setbacks, the process has now been demonstrated to be sound in principle and the product is gaining acceptance both by consumers and by regulatory agencies. Of the three production methods—chemical, biological, and physical—the chemical method is used mostly in the Western Hemisphere and in a few European countries. This method uses solvent extraction to remove water and lipids from the raw material.

Partly because of the development of FPC processes, the annual world fish harvest has nearly doubled in the past decade (now about 57 million tons). It is estimated that the present harvest might be doubled or even tripled before the world catch limit from oceans is reached. Further expansion would have to come through the use of "fish farms."

Now that the Food and Drug Administration has approved FPC for limited use by humans, its utilization in the United States is expected to increase. The Bureau of Commercial Fisheries has reported good results from its research with the use of FPC in bread and cookies. More recent research using FPC in beverages, soups, chip snacks, infant formulas, dietetic foods, and breakfast cereals shows promise. Thus, a new nonagricultural food appears likely to enter the marketplace.

Fish meal is used worldwide as a feed ingredient in livestock rations. Increased use of marine resources for animal feeds releases considerable land inputs for the production of traditional human foods. In one recent and novel situation in Chile, fish milk is being fed to calves as a substitute for cow's milk. Thus, the cow's milk is available for humans. Prior to this development, about 350,000

healthy newborn calves were slaughtered each year in deference to the urgent human needs for cows milk.

Fish milk is derived from the addition of water to a white fish powder which is manufactured from hake-type fish. Fish milk not only has the appearance and taste of cow's milk, but it contains even more proteins than regular milk.

Leaf Protein.—Leaves are the primary source of much of our food, but their high fiber content limits their use for humans. For this reason, we wait until the protein has moved into seeds or tubers, or feed the leaves to animals, and then harvest the altered forms. It is a well-established fact that this conversion wastes time and food energy, although man obviously relishes the converted forms.

Research on the extraction of edible protein from leaves began in the 1930's, but suitable machinery for the process was not in operation until 1957. Large scale commercial extraction apparently must await further refinements. Much of the research has been conducted at the Rothamsted Experiment Station in England under the direction of N. W. Pirie. (An excellent summary of progress to date appeared in *Review* in 1967, Vol. 5, No. 4.)

With the advent of the International Biological Program, interest in leaf-protein extraction picked up considerably, principally in countries where protein is already in short supply. The research activity, however, still lags behind that of fish protein concentrate. Not much is known yet about the acceptability of the product as a food. Its potential usefulness as a substitute food where natural foods are scarce, however, is well established. On a dry-weight basis, the leaf product contains approximately 60 percent protein. Some authorities believe that leaf protein will eventually be best utilized as a supplement to other more conventional foods.

Proteins From Petroleum.—Despite the novelty aspect of "food from oil," the culture of single-cell organisms from various substrates such as hydrocarbons is now recognized as technically feasible. Pilot plants have been set up in this country and abroad and the published literature is already quite extensive. Commercial production for human intake, however, is conservatively estimated as being 5 to 10 years away.

As with all so-called syntheic proteins, products obtained from petroleum or other substrates will have to compete on a cost basis with protein from agricultural products. Present estimates are that it cannot compete even on the basis of a 500 tons-per-day plant capacity. Toxicity is also believed to be a problem with petroleum protein. Because of this, the nutritional and medical effects of petroleum protein may require extensive research before consumer use becomes widespread.

Other Sources.—A great deal of research has been conducted on the use of microscopic algae as a protein source. Although algal protein compares favorably with that of other plant protein, present cost estimates apparently rule it out as a feasible substitute source of food. Moreover, research has yet to answer questions concerning digestibility, palatability, and toxicity.

Most of the amino acids essential for human growth have been synthesized in the laboratory, but again the major deterrent is high production cost. Even if this problem were solved, amino acids would have to be marketed as polymers with a fibrous structure such as commonly associated with the protein-containing natural foods. A limited amount of research is being conducted in this area.

Because of the ingenuity of scientists and continued worldwide demand for more food, it seems quite probable that even more unconventional food sources will be found. As this issue of Review *goes to press, word comes from the Oregon Agricultural Experiment Station that research is being planned on the use of "photofermentation" (laser beams plus microbes) to convert straw residues to protein feed supplements for cattle. Research there has already demonstrated that photofermentation can result in the complete destruction of the molecules that make up lignin—one of the most abundant naturally recurring materials on earth.—Ed.*

RESEARCH IMPLICATIONS

PUBLIC institutions have an important role to play in connection with the problems and challenges posed by synthetic and substitute foods. And while there are obvious extension and teaching responsibilities, the research function is the one requiring the most monetary and mental inputs at the present time.

The following basic types of research need to be strengthened and interrelated: Technical research

and development of new food products, medical and nutritional research relating to new and existing products, and socioeconomic research. These three research areas are applicable to both the development of products for the advanced, market-oriented societies, as well as for the discovery and proliferation of new human foods for populations facing food supply problems.

Technical Research and Development

HISTORICALLY, USDA and the State agricultural experiment stations have tended to emphasize the chemical, physiological and other scientific characteristics and specifications of food produced from traditional agricultural products. In general, this approach is sound because the benefits of basic research tend to be diffused over a wide spectrum of society. Society supports the public research institutions and ultimately expects to receive some long-term stream of reward in the form of better nutrition, lower cost, and improved services.

Some reorientation, however, seems necessary. The alinement of food research with traditional farm commodities might well be modified on the basis that the welfare of the consumer is the primary concern. The source of the food supply is secondary. Food habits do change, and indeed the definition of human food is changing. Decisions concerning research problem areas and approaches must likewise keep pace. For example, many of our current basic food processes are simply developments of traditional kitchen methods. Although science has introduced some radically new processes, overall trends are slow to develop.

It seems regrettable that much commercially feasible utilization research by public agencies is unacceptable to industry because of lack of product exclusiveness. The argument here is that competitors can also utilize the public service patent and market the product. This situation results in some stockpiling of otherwise useful food processing techniques. But it must be kept in mind that, although industry has no responsibility for agriculture per se, the public agencies alone carry the burden not only of demonstrating the potential of the agricultural industry and its diverse raw products, but also of setting standards of wholesomeness and nutrition and helping industry maintain such standards.

Federal and State research has produced significant results in broadening the markets for agriculturally based food through the development not only of new and improved processing methods but also of appealing new uses for natural products. The magnitude of these contributions would be difficult to quantify, and the list of new achievements is growing daily. It seems logical to assume that utilization research deserves a large share of credit for whatever standing the natural foods—and fibers—now have in relation to the synthetics and substitutes.

Medical and Nutritional Research

REGARDLESS of whether one is considering the food and nutrition needs of an affluent or a developing society, the bank of knowledge supplied by medical and nutritional research is as yet inadequate. In the United States the proliferation of new food products has added an unexpected responsibility upon the shoulders of the regulatory agencies designed to protect the general health and welfare. New foods designed to feed starving populations also require careful medical and nutritional analysis from technically qualified, but unbiased, research agencies.

While it may be understandable that some new food products are marketed without adequate medical and nutritional research, it is bewildering that many of our traditional foods succumb to the allegations of competitive products. The animal fats, including butter, have lost their position in the domestic market because of price competition and their possible effect upon the circulatory system, among other factors. Consumption of substitute vegetable oils, therefore, increased sharply. Meanwhile, medical research data on animal fats becomes less conclusive. Recently a London physician-biochemist has advanced the argument that heart disease is more severely influenced by dietary sucrose than animal fat.

Sugar is another case in point. The natural sugar industry has steadily lost ground in recent years to the artificial sweeteners, particularly the cyclamates. Artificial sweeteners were promoted successfully on the theme of diet and weight control. In the last decade, sales have more than tripled. Even before the ban on cyclamates, research agencies had begun to report preliminary findings that cast doubt on the wisdom of substituting cyclamates for natural sugar.

On the basis of laboratory tests, cyclamates reportedly lead to more efficient use of calories and increased appetite. Large dosages may retard growth or damage liver and blood cells. Evidence that cyclamates can cause chromosome breaks in rats—and thus lead to genetic damage—has been documented by the Food and Drug Administration.

The point that needs to be emphasized here is that conclusive empirical evidence is scant; yet the public can be aroused and influenced by partial research results and the claims and counterclaims of advertising messages.

A number of factors complicate the whole situation, particularly insofar as research is concerned. One is the enterprise system which exists in the free world. To a food processor, any natural agricultural product is fair game, and if he is able to devise a marketable substitute, he has little concern for the fate of the natural product he displaces or its producer. Furthermore, the nutritional qualities of his new product are likely to be of secondary consideration. He knows that, in order for his product to sell, it must look good, taste good, feel good in the mouth, and be easy to prepare or serve. Other considerations rate second to these requisites. In contrast, a public research agency would rate nonnutritional characteristics as secondary.

Another factor that introduces complications is cost. With few exceptions, the synthetic and substitute products commercially marketed cost less than natural products. This state of affairs imposes a real challenge to agricultural researchers who are often forced to turn to utilization chemistry to find new uses for the natural products.

A longer shelf life and less need for refrigeration are two other factors that give some synthetic and substitute foods an advantage. Can research find ways to process some natural foods so that they could compete with their counterparts in this respect? Although some notable research has been done in this area, spoilage is still a major factor with agricultural products.

The implications for nutritional and medical research in the agriculturally oriented public institutions are obvious. Not only is there a greater need for nutritional research by home economists and food scientists, but the talents and resources of animal nutritionists and biochemists could be better utilized to study the problems of human nutrition. As food becomes increasingly produced from nonagricultural sources, there will likely be gaping holes in empirical evidence.

There are, of course, numerous medical and nutritional research problems that cannot be answered totally within the agricultural research community. Coordination of research efforts by the medical research centers and universities, the U.S. Department of Health, Education, and Welfare, and the U.S. Department of Agriculture is essential.

Socio-Economic Research

A broad range of social and economic questions can be raised in connection with synthetic and substitute foods when viewed on either a domestic or international basis. In the advanced market-oriented countries, the economic feasibility of new food products must be determined by a careful analysis of the cost, the revenue flows, and the number of years required to recover the initial fixed investment. Although such determinations are ultimately the responsibility of the investor, public research agencies may need to be involved to generate business interest in their more profitable findings. Public agencies may also need to carry out basic research on the economic effect of substituting a new food for a traditional one. In some cases—coffee, for example—the loss or curtailment of the market for a traditional food could seriously affect the economy of an entire country. Also, the disciplines of economics, industrial psychology, and sociology may need to be jointly used to determine the factors affecting consumer use.

Socioeconomic research is particularly needed in developing and underdeveloped countries because of extensive government participation and planning of synthetic and substitute food use and because of the heavy responsibilities of public research agencies. One foreseeable problem would be the need to maximize a country's nutritional standard with a fixed national food-support budget. Systems analysis or mathematical programing could be a useful technique to arrive at an equitable solution. Obviously, the scope of such a problem would have to be broadened to determine the willingness of consumers to adopt new food habits and customs or new flavors and textures of food. And this aspect in turn introduces complex problems of anthropology and sociology.

Of considerable importance to national planners and legislators in both the United States and abroad is public policy relating to the use of synthetic and substitute foods. Changes in the type and composition of human food will invariably affect the agricultural sector and raise numerous agricultural policy questions. Although it is commonly agreed that governments have an obligation to cushion the effects of economic changes and impact brought on by new technology, clearly defined policy guidelines in this respect are not always discernible in the agricultural sector.

Consumer protection and other related laws are necessary to safeguard the national welfare. This involves not only food safety and wholesomeness, but advertising, packaging, and other business ethics. Also, programs and methods may be required to assist agricultural producers who may find themselves displaced or disadvantaged. Moreover, research may also be needed to analyze the impact of changes in synthetic and substitute food sales upon the industrial concentration of the food industry.

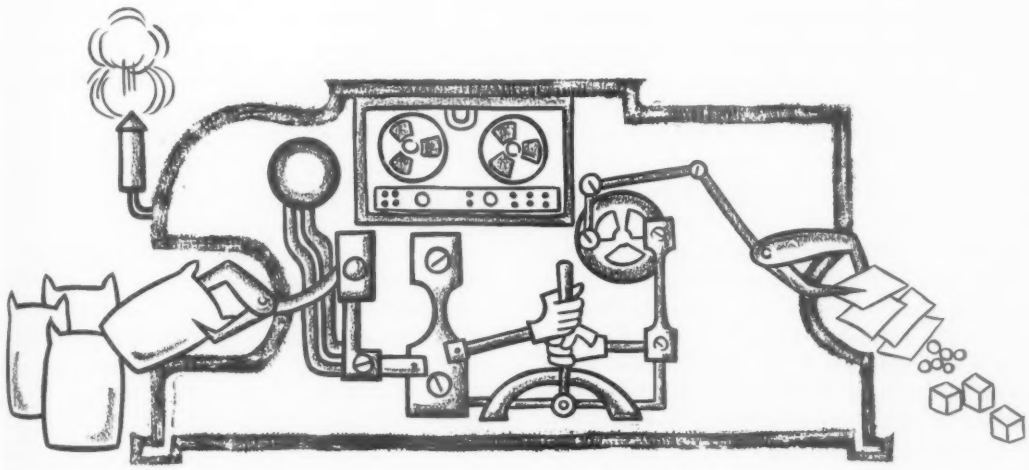
Finally, the population-food supply ratios need to be continually revised for the various countries in light of breakthroughs or changes in the rate of consumption of synthetic and substitute foods. It is possible that the Malthusian crises predicted by many experts will never come about if the public agricultural research sector broadens its focus and applies its creative talents to the world food problem.

A final point in the area of research implications concerns a much broader arena than that related to market position for domestic agriculture. We speak here of the challenges facing agricultural scientists as a result of protein shortages in less-favored countries. Although it may seem logical to be concerned about an agricultural product being displaced in an affluent nation, the situation assumes entirely different overtones when viewed from a global standpoint. Yet we cannot overlook the fact that each person involved in the overall situation tends to formulate conclusions that relate to his own welfare.

We can sympathize with, say, a Wisconsin dairy farmer whose enterprise is being threatened by synthetic milk. But when we take a broader viewpoint and ponder the fact that two-thirds of the earth's inhabitants are affected in some degree by chronic starvation and malnutrition—the technology that comes from a laboratory takes on new significance. The role of research, therefore, becomes as broad as the available resources will permit—whether we're talking about a "green revolution" or a revolutionary synthetic or substitute food.

THE CONSUMER ELEMENT

DECISIONS by consumers can make or break a product. No one can force a consumer to buy a product if for some reason it doesn't appeal to him.



Yet there is always the possibility that his actions can be influenced, and it is this premise that forms the basis for sales drives, advertising campaigns, public information campaigns, or similar efforts. Sometimes they are successful; sometimes they are not. It is conceivable that national circumstances, or other seemingly unrelated factors, could exert influence on consumer decisions. Consider, for example, what consumer reaction to artificial sweeteners might have been if they had been first introduced and promoted during an era when the public was not as diet-conscious as it is today.

As noted earlier in this article, consumers insist on buying products that are not good for them and at times will refrain from buying and using products that would be nutritionally beneficial. These situations result from an unfortunate combination of the persuasive marketing tactics of food manufacturers, an uninformed and apathetic public, and the inadequacy of nutritional research. Although public agencies have an obligation to promote desirable nutrition practices, their efforts should not be limited to the promotion of natural agricultural commodities in excess or burdensome supply. Perhaps a substitute commodity or a semisynthetic one is better for us. At the very least, consumers should be fully informed so that they have the basis for making wise decisions—even though they may not always exercise that option.

The vagaries of taste and custom will undoubtedly influence the extent of market growth for synthetic and substitute foods. Food processors, of course, are quite aware of this condition, and they exert extra effort to formulate a new product in such a way that it matches its natural counterpart or fills voids in the market.

Oddly, although taste and custom currently rate as primary factors in the developing countries, they may eventually become much less important than the are in affluent nations—thereby opening up new markets for unconventional foods. Suppose, for example, a protein-deficient country begins feeding milk made from fish protein concentrate to children of weaning age. Perhaps other unconventional foods would be added to the diet as the children grow older. Within a generation or two, the taste preferences of an entire nation could change. This situation is less likely to happen in an affluent nation where consumers would be able to support a technology that would bring them taste sensations to which they are accustomed—even though they might be derived from substitutes.

* * *

Depending on one's viewpoint, synthetic and substitute foods can be either a challenge or an opportunity. Both elements of the situation are obviously present for agricultural scientists, although it is difficult to predict how much they will be challenged or how varied or vast the opportunities. One thing, however, is certain: The continued proliferation of synthetic and substitute foods. Whatever standing they may enjoy by the time this century closes, we might reasonably assume that both producers and consumers will have learned to adjust where necessary. Hopefully, science and education will apply their full complement of resources to temper the impact.

Salvation Jane -- Weed Or Feed?

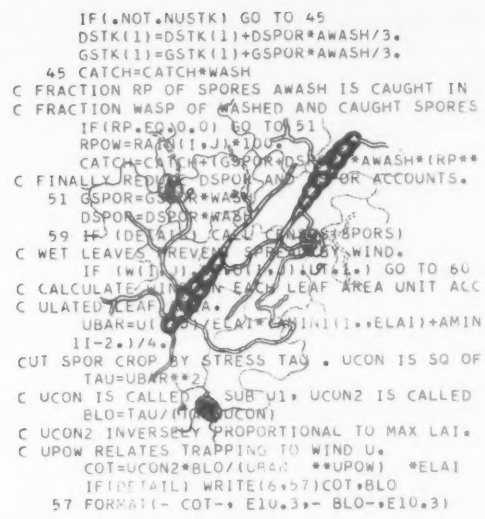
MANY farmers in South Australia consider salvation jane [1] good sheep feed, but others, when they look at their bright blue paddocks in spring, are not so sure. They remember drought years and the stock they were able to carry on jane. But they also think of the good years when its large flat rosettes drastically reduced the development of more desirable pasture grasses.

This is the situation in a nutshell. Salvation jane is fair feed, but not the best feed.

Where there is much jane, pasture improvement is the answer. Where the paddock still has a fairly good pasture—even though it may be badly infested with salvation jane—spraying with 2,4-D will control jane sufficiently.

From: *Journal of Agriculture* South Australia 72:8, 1969

[1] *Echium lycopsis* L. Also called Patterson's Curse.


IF(.NOT.NUSTK) GO TO 45
DSTK(1)=DSTK(1)+DSPOR*AWASH/3.
GSTK(1)=GSTK(1)+GSPOR*AWASH/3.
45 CATCH=CATCH*WASH
C FRACTION RP OF SPORES AWASH IS CAUGHT IN
C FRACTION WASP OF WASHED AND CAUGHT SPORES
IF(RP.EQ.0.0) GO TO 51
RPOW=RAIN(I,J)*10.
C FINALLY, CREDIT DSPOR AND GSPOR ACCOUNTS.
51 GSPOR=GSPOR*WASP
DSPOR=DSPOR*WASP
59 IF (DETAIL) CALL CENTER(SPORS)
C WET LEAVES PREVENT SPORE RELEASE BY WIND.
C CALCULATE WIND ON EACH LEAF AREA UNIT ACC
C ULATED LEAF AREA.
UBAR=U(
11-2.)/4.
CUT SPOR CROP BY STRESS TAU . UCON IS SQ OF
TAU=UBAR**2
C UCON IS CALLED SUB U1, UCON2 IS CALLED
BLO=TAU/(
C UCON2 INVERSELY PROPORTIONAL TO MAX LAI.
C UPOW RELATES TRAPPING TO WIND U.
COT=UCON2*BLO/(UBAR **UPOW) *ELAI
IF(DETAIL) WRITE(6,57)COT,BLO
57 FORMAT(- COT-, E10.3,- BLO-,E10.3)

EPIDEM

A Simulator of Plant Disease Written for a Computer

AN epidemic marching through a population of plants, animals, or men reflects the integration of a very large number of factors in the environment and characteristics in the pathogen and host. These act and interact on each other in a fabulous array that boggles the mind.

Taken in bits and pieces, however, single steps in the life of the pathogen can be re-created in the laboratory of the biologist, and he can measure the effects of the weather, one element at a time, upon a single step. For example, the effects of temperature or light or humidity upon several steps in the life of *Alternaria solani,* the cause of early blight of tomato and potato, have been measured.

With rapid and capacious information machinery at hand, we were encouraged to draw the bits and pieces from the libraries and compose them into the beginnings of a simulator. During the composition, the complete system of weather, pathogen, and host had to be examined, and this led to critical experiments that had been missed. These missing experiments were run, and the simulator was completed.

The simulator, which we call EPIDEM, mimicked several actual epidemics of past years, indicating that the pathology incorporated into EPIDEM was adequate. After the simulator was verified, it provided a guide to the importance or influence of the characteristics of the fungus, the weather, or the host. It also provided a predictor for the outcome of modified weather.

The foregoing overview is now expanded into a fuller summary.

The simulator employs the temperature, relative humidity, wind speed, sunniness, and wetness for each 3 hours of each day. Each 3 hours, it modulates the course of the following fungal stages according to the different, sometimes opposite, effect of the weather factors upon them: formation of conidiophores, formation of spores, departure of spores on wind or rain, finding a host, germination of the spores, penetration of the host, incubation of the infection, and expansion of the lesion.

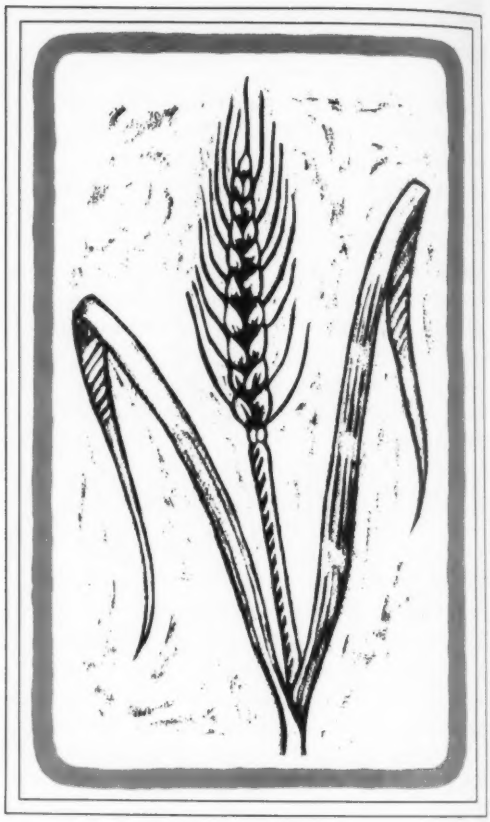
Information in the literature was adequate to begin composing the simulator. For example, biologists had already carefully measured the different effect of temperature upon sporulation in the light and in the dark. And since the simulator was to be logical and run like the fungus, this interaction

(*Continued on page 29*)

The accompanying article is a reprint of the full summary section of Bulletin 698, *EPIDEM—A Simulator of Plant Disease Written for a Computer,* Connecticut Agricultural Experiment Station, New Haven, 1969. EPIDEM represents a classic example of the advantageous use of computers in solving some of the complex problems in agricultural research.

HYBRID WHEATS

Their Development and Food Potential



EVER since the successful development of commercial corn hybrids in the 1930's, plant breeders have sought to utilize the principle in self-pollinated crop plants such as wheat, rice, barley, and sorghum.

In comparison with these other cereals, however, the development of hybrid corn was relatively easy. Corn is a cross-pollinated plant, and even before the development of a male sterile and fertility restorer system, enormous quantities of commercial hybrid corn seed were produced in the United States by hand detasseling of the female line and cross-pollinating from the male line. In contrast, the mechanism of normal seed production in self-pollinated plants makes hybridization a much more difficult problem. The enclosure of both male and female flower parts within the same set of protective glumes results in nearly complete self-fertilization in such plants.

The basic procedure for producing a single hybrid wheat seed requires a series of delicate, exacting, properly-timed, and tedious hand operations with a pair of small forceps. Obviously, such a technique cannot be used to produce commercial quantities of hybrid wheat seed.

Development of the cytoplasmic male sterility and restorer system, however, has considerably improved the prospects for commercial production of hybrid wheat. Sorghum was the first self-pollinated field crop in which this system was used to produce commercial hybrids. It appears that if the research

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This article is based on Research Bulletin No. 3, under the same title, published by the International Maize and Wheat Improvement Center, Mexico. The original publication, authored by Ricardo Rodriguez, Marco A. Quinones L., Norman E. Borlaug, and Ignacio Narvaez, consisted of both a case study of the Mexican program and an evaluation of the research problems in general. For this article, emphasis was given to the review aspects.

now underway is successful, wheat may soon become the second self-pollinated field crop where hybrids will be used.

CYTOPLASMIC STERILITY AND POLLEN FERTILITY RESTORATION

A Japanese scientist, H. Kihara, first reported cytoplasmic sterility in wheat in 1951, which was about the same time cytoplasmic sterility was reported in corn and sorghums. He found cytoplasmic sterile plants in the progeny obtained from crossing "goat grass," a wild relative of wheat, with a common bread variety—♀ *Aegilops caudata x* ♂ *Triticum vulgare*. H. Fukasawa, also a Japanese scientist, in 1953 found cytoplasmic sterile plants in segregates from a cross of a different species of goat grass with durum wheat—♀ *Aegilops ovata x* ♂ *Triticum durum*.

In 1955 Fukasawa reported he was able to restore pollen fertility to a cytoplasmic male sterile derivative containing the cytoplasm of *Aegilops ovata* by crossing it with a species of wild emmer (*Triticum dicoccoides*).

In 1958 Kihara reported he had developed both cytoplasmic male-sterile and pollen fertile lines from the cross ♀ *Triticum timopheevi x* ♂ *Triticum dicoccum* (emmer).

Although the scientific basis and principles for hybrid wheat development were laid by the aforementioned discoveries, there were too many adverse side effects in the plant materials used in the *Aegilops* studies to serve as a sound basis upon which to develop a commercial hybrid wheat. Nearly a decade passed without much research effort devoted to finding better tools for making a commercial hybrid. Kihara's report in 1958 based on *T. timopheevi*, however, brought the possibilities of finding the right tools a lot closer.

The right tools were finally found in late 1961. J. A. Wilson and W. M. Ross of the Kansas Agricultural Experiment Station isolated stable cytoplasmic bread wheat lines from a cross of *Triticum timopheevi* as the female parent and employing the winter habit bread wheat variety Bison as the male. Sterile plants from this cross repeatedly used as the female parent were back crossed several times and resulted in cytoplasmic male sterile Bison lines.

Eight months later J. W. Schmidt, V. A. Johnson, and S. D. Maan of the Nebraska Agricultural Experiment Station found that they could restore the fertility to the Bison cytoplasmic male sterile line developed at Kansas by crossing it with a *Triticum timopheevi* bread wheat derivative. Shortly after, Wilson confirmed similar results on restoration of pollen fertility.

Prior to 1962, only a few scientists were engaged in research on hybrid wheat, but the discoveries in Kansas and Nebraska triggered off a lot of interest. At present, at least 15 States are actively engaged in research to produce commercial hybrids. Research on wheat hybrids is also being done in Canada by the University of Manitoba and the Canada Department of Agriculture. The Kansas and Nebraska Agricultural Experiment Stations have also distributed cytoplasmic male sterile and pollen fertility restorer stocks to scientists in many countries.

The Mexican hybrid wheat research program began in 1962 and has now grown into a large, aggressive effort. At present, about 20 percent of the overall wheat research effort is in the development of hybrids.

When one considers the economic importance of the cytoplasmic-male sterility and pollen fertility restorer systems in the production of commercial corn and sorghum hybrids, it is surprising how little is known about its fundamental nature and mode of action. The following is the best hypothesis that can be advanced to explain the system:

Apparently the production of normal anthers and fertile pollen in wheat plants results from the harmony and balance that exists between specific chromosomal genes (the unit carriers of heredity that are arranged in linear order on the thread-like chromosomes in the nucleus), and between the little understood "nonchromosomal genes," located in the cytoplasm outside of the nucleus. When the genes in these two independent but interacting systems are in equilibrium and balance, anthers develop normally and fertile pollen is produced which results in normal seed production. Apparently in certain wheats there are defective or mutant nonchromosomal genes which inhibit normal anther and pollen production. If, however, the corresponding corrective dominant fertility restorer genes are present in the chromosomes of the nucleus, the adverse effect of the defective nonchromosomal genes is not expressed and the plant produces normal anthers and pollen. Amazingly, such nonchromosomal genes ad-

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versely affect only anther and pollen development; they have no adverse effect on the development of the female parts of the same flower (that is, the stigma and ovary), and consequently when pollinated with fertile pollen they produce seed normally.

In recent years geneticists and plant breeders have developed ingenious techniques for throwing out of balance the equilibrium or harmony that exists between the defective cytoplasmic nonchromosomal genes and the corresponding corrective chromosomal genes. Through a system of crosses and backcrosses the two component parts of these two systems are separated. One component, the cytoplasm with its defective nonchromosomal genes is diverted and incorporated into the cytoplasmic male sterile line, which eventually will become the female parent in making the final hybrid. The second component, the dominant pollen fertility restorer chromosomal genes, are transferred into a commercial variety which will become the male parent in making the cross to produce the hybrid seed.

When the cross is made to produce the hybrid seed, the two components of these two independent but interacting systems are brought back together and into harmony once again, thereby resulting in restoration of pollen fertility in the hybrid seed.

HETEROSIS IN WHEAT

THERE is no point in developing hybrid wheat varieties unless a high degree of hybrid vigor or heterosis can be effectively and economically utilized.

Briggle, in a survey of the literature in 1963, cites 23 scientists who have published data on heterosis in wheat. These studies in most cases were very limited in scope and application, and were largely academic. In many cases they relate to heterotic effects on plant height, maturity, tillering, seed size, and weight of the above ground plant parts. Only a few of them relate to heterosis in grain yields. Moreover, nearly all of the early studies were based on a few individual plants and frequently they related to experiments performed under greenhouse conditions. The few experiments done in the field were limited and based on single rows of F_1 plants with few or no replicates. The magnitude of heterosis that was reported ranged all the way from zero to more than 100 percent increases over the yield of the parents.

With few exceptions, these early studies are meaningless as a basis for determining the feasibility of commercial hybrids. Frequently in the early studies, two unimportant varieties were crossed and the progeny resulting from such crosses were studied for heterosis. The magnitude of increase in grain yield over that of the highest yielding parent entering the cross, therefore, has no relationship to the possible development of an acceptable commercial hybrid. Before large heterotic effects can be of economic significance they must be superimposed upon the yield base of the highest yielding commercial variety available in the region for which the hybrid is being developed.

Even though the early studies demonstrating heterosis had little practical value for orienting research designed to develop hybrids, they have been supplemented by wheat breeders who have observed many cases of heterosis while working in broad, aggressive breeding programs. In the past 20 years we have observed more than 26,000 F_1 populations in the Mexican wheat breeding program. We have noted outstanding cases of heterosis in many of these crosses but until our hybrid research program was initiated we had made no effort to measure the heterotic effects quantitatively.

The combination of many interacting economic and technical factors will determine the ultimate economic feasibility of hybrid wheat. The most important consideration is whether the increase in yield due to heterosis will be sufficiently great to offset the higher costs of hybrid wheat seed.

There are many other scientific and technical problems such as the incorporation into the hybrid of acceptable milling and baking quality, a high level of disease resistance and desirable agronomic type which also must be achieved before hybrids will become realities. The latter are all attainable through research if the aforementioned problem of the relative benefits from heterosis and hybrid seed costs can be brought into favorable economic balance.

After studying 45 F_1 experimental hybrids during the past 2 years at a very low rate of seeding, it becomes apparent that heterotic responses of from 15 to 30 percent are quite common in wheat. Some hybrids have shown less, whereas a few have shown more than 40-percent increase above that of the highest yielding parent. In all probability, the magnitude of heterosis that can be found in wheat is

similar to that which currently is being utilized in corn and sorghum for the production of commercial hybrids. After 2 years of research, we are convinced that the magnitude of heterosis encountered in wheat is sufficient to make the production of hybrids feasible if hybrid seed production problems can be solved. The utilization of advanced generations of F_1 hybrids to reduce seed costs does not appear promising on the basis of our information.

INDUSTRIAL QUALITY ASPECTS

INDUSTRIAL quality considerations were unimportant in the development of hybrid corn and sorghum, since both of these cereals are used primarily as feed grains. The situation will be entirely different in the development of hybrid wheat, since this cereal is used almost entirely for human food. Most wheat exporting countries now evaluate the milling and baking quality characteristics of all new experimental wheats in cooperative tests in governmental and industrial laboratories. Only those experimental wheats which meet the requirements of industry as well as the farmer are multiplied and released for production.

Research has shown that the cytoplasm of *Triticum timopheevi* does not adversely affect several of the grain and dough handling characteristics. In all probability, therefore, there should be no unsurmountable quality problems in hybrid wheat development if the breeding programs are properly organized to consider the quality aspects.

All grain harvested from a pure line wheat variety is identical, from a genetic standpoint. This will not be the case with the commercial grain harvested from an F_1 hybrid wheat variety. Such grain will be a segregating F_2 endosperm population. Consequently, there could be considerable variability in both physical and chemical properties between different kernels of such a population. The milling, dough handling, and baking characteristics manifested by such grain will therefore be the average value for this heterogeneous population. Variability in the endosperm population from a quality standpoint can be minimized by employing parents of similar quality characteristics in making a hybrid.

AGRONOMIC ASPECTS

Dwarfness and Lodging Resistance

THE development and distribution of high-yielding semidwarf and double-dwarf Mexican wheat varieties greatly reduced lodging, while simultaneously permitting heavier fertilization, thereby resulting in phenomenal increases in grain yields. The use of semidwarf and dwarf varieties has been directly responsible for increasing the national average of grain yield in Mexico by 1,000 kilos per hectare during the past 3 years. The impact of these varieties has been so great that they have taken over more than 95 percent of the wheat acreage in Mexico in 4 years' time. The sources of dwarfness in all of these varieties are the "Norin genes," whose action is inherited as recessives.

All of the highest yielding F_1 experimental hybrids have been the result of crosses between Mexican dwarf varieties and conventional tall-strawed varieties. The F_1 plants in all such cases are nearly as tall as the tall parent. Such tall hybrids will lodge badly when grown under commercial conditions, and because of this defect would not be acceptable to Mexican farmers, who are now thoroughly convinced of the benefits of dwarf varieties.

If the Norin genes are to be used to produce dwarf hybrid varieties, it will be necessary to introduce dwarfness into the hybrid through both parents. This will restrict the Mexican hybrid program for the near future to using as parents the

dwarf varieties within the Mexican program, since there are no other countries which curently have commercial dwarf spring wheat varieties. This limitation will prevent the direct use of tall-strawed Canadian, United States, and Argentine varieties in the formation of hybrids. Tall-strawed varieties from these three countries must first be converted to dwarf varieties by incorporating the Norin genes into them through a backcross program, if they are to be used as parents in hybrids for the Mexican program. Such a procedure will be both time-consuming and expensive.

Resistance to Shattering

THE Mexican wheat crop is harvested by direct combining under conditions of high temperature and low humidity. Consequently, all commercial Mexican varieties are resistant to shattering. Several of the most extensively grown North American spring wheat varieties, such as the U.S. varieties Justin and Crim, and the Canadian variety Selkirk, shatter badly when grown under Mexican conditions. This weakness is, however, of no consequence when these varieties are grown in their native habitats where most of the harvest is done by swathing followed by combining.

Several of the most promising experimental hybrids that were studied during the 1964–65 season were crosses between Mexican varieties and Crim, Justin, and Selkirk. All of these hybrids shattered badly under Sonora conditions. This defect indicates another problem that must be dealt with in developing commercial hybrid wheats. Fortunately, a number of other hybrids which also showed considerable promise did not have this weakness.

Rust Resistance

THREE different commercially important species of rusts, each one made up of hundreds of different physiologic races, attack wheat. All are obligate parasites. The specificity of the pathogenecity of these organisms is extremely great. Certain races, stem rust, for example, tend to predominate throughout a large geographic area on certain wheat varieties which are congenial hosts for these particular races. The race population within a given geographic area over a period of years will be made up largely of races capable of attacking the extensively grown wheat varieties of that region. When a variety of wheat with a new type of rust resistance is distributed and becomes widely grown in the region, it will remain free from rust attack for a number of years, but sooner or later a new race of the rust will evolve, either through hybridization on its alternate host or through mutation, which will be capable of attacking this new variety.

Wheat is a self-pollinated crop and all individual plants in a conventional pure-line variety of wheat are identical genetically for rust resistance. When a new race of rust appears, which is capable of attacking a previously resistant variety, it will spread like wildfire in such a population, and if ecological conditions are favorable it will cause devastating epidemics which may bring economic ruin to a large geographic area. Equilibrium between host and parasite and security of harvest cannot be reestablished in that region until a new variety is released which is resistant to the new physiologic race, as well as to all other rust races which are prevalent in the region. The variability in the genus *Triticum* is so great that there has been no difficulty in locating sources of resistance to any given race and developing a variety resistant to it; however, the bigger and more difficult problem is maintaining the desired level of resistance in a variety against all prevalent rust races throughout a geographic area over a long period of time.

The first hybrid wheat varieties will be single crosses. They will probably afford a level of protection from rust similar to that being provided by the currently available conventional pure-line varieties. Development of a multilineal hybrid wheat variety cannot be justified until a truly outstanding single cross hybrid has been developed and its value proven commercially. Nevertheless, better rust control which might result from the development of multilineal hybrids could be one of the greatests benefits that eventually will come from hybrid wheat.

ECONOMIC ASPECTS

Production Problems

THERE is still a great scarcity of information on factors affecting the production of hybrid seed costs. During the past three years, however, there has been considerable experimentation conducted in different parts of the world designed to obtain in-

formation on various problems of hybrid seed production, such as the percentage of seed set when the two parents are located at different distances from one other. This information is basic to the calculation of hybrid seed production costs.

The majority of these experiments have been largely academic however, and usually have consisted of a few emasculated plants located at varying distances from a large plot of the pollinator. In such experiments, where pollen concentration has been high, seed sets generally have been good—often running between 60 to 80 percent. These types of experiments have contributed very little practical information, and may actually be misleading.

A few scientists, however, have studied seed set on cytoplasmic male sterile lines sown in plots at different distances from strips of pollinators. Results have been extremely variable. Seed set varied from 30 to 80 percent, even when a proper synchronization was obtained between the flowering of the two parents. Moreover, the apparent seed set, at least in some cases, has been misleading since the so-called male sterile lines have been found to be partially pollen fertile. Where male sterile lines with incomplete sterility have been used, it is impossible to determine what percentage of the total seed set is due to crossing and what part is attributable to selfing.

It has become clear after a number of these studies that accurate and meaningful information will not be obtained until such tests are conducted on semicommercial field strips, employing cytoplasmic male sterile lines that are completely sterile.

More extensive and accurate information on seed set on stable cytoplasmic male sterile lines grown under semicommercial conditions is urgently needed as soon as possible to obtain trustworthy data on potential hybrid seed production costs.

At present no one is able to accurately predict what percentage of seed set can be obtained on cytoplasmic male sterile lines under field conditions. Neither is anyone able to foresee the width of strips of pollinator or restorer lines that must be sown in proportion to the cytoplasmic male sterile line. Moreover, no one is currently able to predict the climatic and geographic conditions under which a high seed set can be assured. Until there is more extensive and accurate information on all of these points, it is impossible to predict the future role of hybrids in commercial wheat production.

Within the next 2 years many different wheat breeders will have developed and multiplied cytoplasmic male sterile lines to a point where they can be evaluated in strips to determine the percentage of seed set. Only then will a realistic picture of seed production costs become available.

THE widespread acceptance of hybrid wheat by farmers will depend entirely upon whether the amount of heterosis or extra yield obtained from planting hybrids will offset the higher seed costs, and in addition leave a reasonable increase in income for the additional investment. This balance of additional cost versus income will be different for different wheat producing areas, depending upon the average yield per acre and seeding rate in the area under question.

Twenty percent of heterosis will offset somewhat more than $15 additional seed cost input per acre in countries such as France, Denmark, Holland, and West Germany where per-acre yields are high. It drops to a level of $10 per acre in Italy and Poland and to a low of $6 per acre in Spain. The level of compensation for all of Europe and for the United States and Mexico is approximately $10, and for Canada $8. Where average yields are low, as in India and Pakistan, 20 percent of heterosis will offset an additional seed cost input of only $4 per acre.

National average yields are, however, misleading as a basis for estimating the potential economic feasibility of hybrids. A more realistic basis is a regional approach. The average per-acre yield in Illinois, Indiana, Ohio, and Michigan—chief producers of soft red winter wheat—is 34.5 bushels, whereas the principal producers of hard red spring wheats—North Dakota, Montana, and South Dakota—have an average yield of only 11.6 bushels per acre. Obviously the chances of the economic success for hybrids are greater in the soft red winter wheat region where 20 percent of heterosis will offset additional seed cost inputs for hybrid seed of more than $14 per acre in contrast with the hard red spring wheat region where the same level of heterosis will offset only slightly more than $4 per acre.

A changing agriculture will likewise improve the chances for successful use of hybrids. Within the past 2 years, mainly as a result of the widespread use of dwarf varieties combined with heavier fer-

tilization, the national average yield of wheat in Mexico has risen to 39 bushels per acre. Areas such as Sonora and Sinaloa now have pre-acre average yields of more than 55 bushels. These areas can afford to increase considerably the money expended for hybrid seed per unit of planted area if high levels of heterosis are assured.

Seed Production

WORLD wheat acreage is considerably greater than for any other cereal crop. Moreover, the seeding rate per unit of area is considerably greater in wheat than for such crops as corn or sorghum where hybrids are now used. The wheat seed sown annually in the United States and Canada alone is about 70 million bushels, assuming an average seeding rate of one bushel per acre. Nevertheless, a large part of the commercial wheat-producing areas of the world is located in ecological zones where yields are low and where moisture is the factor which primarily limits yield. However, even when these low yielding areas are excluded in calculating the possible hybrid wheat seed market, the potential market remains very large. The hybrid wheat seed market is potentially a huge business. Private seed companies have played a major role in the development, promotion, production and distribution of corn and sorghum hybrids. Without the actual participation of private seed companies in all of these activities, it is doubtful that hybrids would have achieved widespread commercial acceptance.

In all probability the production of hybrid wheat seed will be even more beset by technical problems—especially those related to pollination—than in the case of corn or sorghum. Moreover, distribution of larger volumes of hybrid seed will need to be handled and this will require a large and efficient organization. If hybrid wheats become feasible, the only agencies now capable of producing and handling this volume of seed are the private seed companies. Governmental agencies must increase budgets, train personnel, and create greater freedom of operation in order to cope with an undertaking of this magnitude.

RESEARCH PROBLEMS

THERE now appears to be no insurmountable hurdle to the development of successful hybrid wheat varieties for areas where wheat is grown as an intensively cultivated crop. Hybrids will first become economically feasible where wheat is grown in areas of adequate rainfall, or under irrigation, either of which will permit the use of heavy doses of fertilizer, thereby resulting in high yields per unit of area. As increased knowledge permits improvements in the efficiency of hybrid seed production, seed costs will decrease and gradually permit the extension of hybrids to areas of lower per acre yield.

Despite the fact the production of commercial hybrid wheat varieties looks promising, much more

research is needed to increase our knowledge and understanding of the cytoplasmic sterility and restorer systems in wheat. The male sterility system based on *Triticum timopheevi* cytoplasm is much more complex than the corresponding systems currently being used in the production of commercial hybrids of corn and sorghum.

Most investigators have reported that two genes are involved for complete restoration of pollen fertility in the *T. timopheevi* system. Other scientists have shown that under certain ecological conditions and with certain varieties, at least three genes, and perhaps more, are involved in restoration. A few varieties are very difficult to sterilize when their nucleus is incorporated into *T. timopheevi* cytoplasm. The reason for this phenomenon is unknown. Moreover, considerable difficulty has been reported in developing cytoplasmic male sterile lines that remain sterile under a range of different ecological and climatic conditions.

Before satisfactory hybrids can be developed it will be necessary to develop cytoplasmic male sterile lines which remain completely sterile under a wide range of conditions. Such lines exist. Within the past year the Mexican program has been able to isolate lines with complete pollen sterility at Ciudad Obregon, Sonora, which has ecological conditions very favorable for anther and pollen development (28° N and 125 feet elevation). Some of these lines have been equally as sterile at Chapingo, Mexico, at a latitude of 18° N and an elevation of approximately 7,400 feet.

The discovery of a single dominant gene for the restoration of pollen fertility for the *T. timopheevi* cytoplasmic male sterile would greatly simplify the development of hybrids.

A dominant single gene which will control plant height also is needed for the development of dwarf hybrids. The recessive Norin genes, which have been used with great success in the development of such commercial varieties as Gaines (United States), Pític 62, Penjamo 62, Senora 64, Lerma Rojo 64 (Mexico), are difficult to use in hybrids. Currently, considerable research effort is being made to find a dominant gene in either naturally occurring dwarfs or in mutant populations.

More research is needed to find stigmas, filaments, and anthers that are better suited to hybrid seed production. During the 1964–65 season a preliminary study was made of the variation in flower structure of approximately 200 lines and varieties in the Mexican program. Considerable variation was found in filament length, anther size, and in the manner the anthers were exerted. Unfortunately, in this study no lines were found which were clearly superior in stigma length and exertion. If male sterile lines could be developed with better exertion of the stigma it would result in a higher percentage of seed set and thereby reduce hybrid seed production costs. Much more research effort is justified in this area of investigation.

Within the past 2 years a vast amount of research effort that was formerly directed toward the development of conventional improved pure line wheat varieties has been diverted to hybrids. Even after hybrid wheat becomes a commercial success, the longtime continued success of hybrid breeding programs will depend to a large extent upon the continued production of better basic lines and varieties which can be converted into parents for the production of better hybrids. Continuous aggressive conventional breeding programs producing newer and better lines will, to a large degree, always set the base level of yield, quality, disease resistance, and breadth of adaptation upon which the improvements in future hybrids will be superimposed.

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SALUTE TO A BRITISH JOURNAL

IN September 1894, British agricultural authorities modestly launched the first issue of a staid agricultural journal that was regarded as a medium for reporting statistical and other information "accessible to the Board of Agriculture."

Queen Victoria was then in the 58th year of her reign, and the second Board of Agriculture was almost 5 years old. Permanent Secretary of the Board was Sir Thomas Elliott, who once told the director of the Rothamsted Experimental Station, Sir Daniel Hall, that agriculture in England was dead and the Board's business was to bury it decently.

Both the journal and the industry it serves are far from being "dead." The journal, now celebrating its 75th anniversary under its new title, *Agriculture*, has long since dropped the statistical look. Instead, it presents practical and interesting articles, notes, and book reviews on general farming, written by specialists and experienced growers. It has become an invaluable aid to every British farmer and grower, and is avidly read in all the colonies.

The 75th anniversary issue of *Agriculture* marks a milestone of progress in communicating information from the laboratory to the farmstead. *Review* is happy to recognize this publication achievement of the Ministry of Agriculture. That the journal will remain viable for another 75 years would seem to be a logical assumption, if only for the reason that the wellspring which feeds it—agricultural science—is encouraging far-seeing scientists to generate ideas for solving the problems of the next century.

SELF CONCEPT

Its Role in Breaking the Poverty Cycle

SARAH M. SHOFFNER

The following article is somewhat of a rarity—not because of its content, but because of the purpose for which it was originally written. It was adapted from an extensive literature review designed to establish one segment of the knowledge base for a regional research project.[1] *The author is a member of the technical committee assigned to the project.*

The original review synthesized research findings in terms of the specific hypotheses of the regional project, and gave the committee a common base of understanding in their approach to solving the problem of breaking the poverty cycle. Some researchers apparently do not consider this review procedure as a logical step in the research process. But it is particularly useful in the social sciences where approval is more tenuous and where scientists of different competencies from different regions need to reach a unanimity of purpose in tackling a social problem.

This article, therefore, serves two purposes. (1) To give an overview of a research problem area, and (2) to serve as a model of an important step in the research process. Not all of the original citations are included in this article. The regional project, incidentally, is still in the early stages of operation.

[1] S-63, Influences on occupational goals of young people from three sub-cultures in the South.

Recent research has given new credence and validation to the old maxim: "To enlarge what a man can do, you must first enlarge what he *thinks* he can do." There is now further reason to believe that in order to upgrade the aspirations and expectations of rural youth—or even adequately measure them—close attention must be given to self-concepts.

Evidence seems to imply that people important to another person can profoundly influence that person's self-concept. As might be expected, both family status and quality of the environment are significant factors in influencing self-concept. More important, there is a growing body of evidence indicating that significant relationships exist between self-concept and both educational and vocational aspirations.

Self-Concept and Significant Other Persons

THE individual's self-image is largely made up of what others think of him. Evidence seems to imply that people who are important to another person can profoundly influence that person's self concept (*18, 22*).[1] The significant other persons affecting the childs feelings about himself are first the parents and then the teachers. The more positive a child's perception of his teacher's feelings, the better his academic achievement and the more he will show desirable classroom behavior as rated by the teacher. According to one study (*7*), a child showing a more favorable self-image was the one who perceived the teacher's feelings toward him as favorable. In a study with eighth-grade Negroes, the best single predictor of academic achievement was the teacher's estimate of the subject's self-concept (*8*). It has also been demonstrated that self-concepts of students can be altered by the teacher by making positive comments to them and by trying to establish an atmosphere of psychological security (*26*).

Further teacher-pupil interactions were demonstrated in a study of fifth- and sixth-grade students by the University of Arkansas (*17*). Teachers tend to rate themselves significantly lower in esteem than they rate a student who is considered most desirable to teach. This imbalance applies even when a teacher tends to rate herself high in self-esteem. Over time, teachers tend to perceive the student considered least desirable to teach with less esteem, or as having negative traits to a greater degree. But these teachers, oddly, tend to facilitate the achievement of greater self—ideal self-congruency in their pupils.

Two basic assumptions have been suggested as underlying current theories of self: (1) Self-concept is a product of social reaction, and development and change in self-concept are direct functions of the response of significant others; and (2) self-concept has a predictable effect on behavior generally; that is, certain behavioral consequences are directly related to an individual's concept of self. These assumptions were tested in a study (*15*) of seventh- and eighth-grade boys. These boys were asked to perform various physical tasks in front of a physical development expert—the significant other person—who made either approving or disapproving statements to the subjects. Increases in self-concept followed the approving treatment; decreases in self-regard followed the disapproving treatment of the significant other person. This reaction supports the hypothesis that changes in self-concept were significantly related to reactions of important others.

The researchers who conducted this study were concerned with whether changes in self-regard would be followed by changes in behavioral preferences. Subjects receiving approval indicated an increased preference for activities that had received approval. This increased preference in the approval group persisted longer than the decreased preference in the disapproval group.

Self-Concept of the Disadvantaged

LONG and Henderson (*14*) hypothesized that social discrimination, broken families, and poor and crowded living conditions would produce in the disadvantaged child self-conceptions which would tend to be negative and alienate him from others. Although the study of these researchers was limited to a specific sample of disadvantaged Negro school beginners in a southern rural community, they demonstrated that the self-social concepts of disadvantaged children differ significantly from those of the more advantaged children. Disadvantaged children were found to have lower self-esteem and a less realistic self-concept for color, less identification with the father, and greater identification with the mother and teacher.

Boys and girls within the disadvantaged group differed. The boys tended to be more realistic and identified less with the mother and teacher. The teachers' ratings also tended to be lower for the boys. The children who rated highest on the total scale had significantly higher self-esteem than those rating low.

The lower self-esteem suggests that low status of a family, plus the reinforcement of racial caste system, can penetrate a 6-year-old's self-image. The study suggests that "for the Negro child, a realistic acceptance of the self as dark" may be one aspect of and possibly a prerequisite for an adequate self-esteem and a good relationship with peers. Also, because lower self-esteem is associated with less mature classroom behavior, a low self-esteem may have an ad-

[1] Italic numbers in parentheses refer to Literature Cited, p. 28.

verse effect upon school performance, even at this early level.

Although evidence is inconclusive, at least one researcher feels that the self-esteem of the disadvantaged child is largely based on the status and self-esteem of the parents (*22*). One example given is the case of the son of a laborer who alines himself with his self-rejecting father. The father judges himself as he feels society judges him, and this condition heightens a lower self-esteem for the son. Being a member of a minority or immigrant group may lower self-esteem even further, and a negative self-image is likely to develop.

Negro and white children differ significantly in self concept as measured by self-ratings of intelligence (*9*). The Negro children achieved significantly greater discrepancies between their actual I.Q. scores and their ratings on the self scale than the white children.

In general, the environmental press of the American color-caste system tends to develop negative self-concepts in Negro children who, as a result, show defeated behavior academically. If the reflected appraisals of which the self is made up are mainly derogatory, then the growing child's attitudes toward himself will be mainly derogatory. The child toward whom the predominant attitude of significant persons has been one of hostility, disapproval, and dissatisfaction will tend to view the world in similar terms. He will have difficulty in seeing or learning anything better, and although he may not openly express self-depreciatory attitudes, he has a depreciatory attitude toward others and toward himself (*13*).

These negative self-concepts are of great concern to educators because they are often hidden from the view of the untrained observer.

Self-Concept and Scholastic Performance

A number of studies present evidence that the way a child performs at school and even his willingness to stay in school are highly influenced by the view he holds of himself (*18, 21, 22, 24*). Indeed, it has been noted that changes in performance level or changes in behavior are commensurate with changes in self-concept.

This latter theory was tested by Shore, et al. (*23*) in a study of the relationship of psychotherapeutic change to attitude toward authority, control of aggression, self-images, and academic performance with a group of delinquent boys 15 to 17 years old. There were highly significant changes in the treatment group and deterioration in the control group. Results indicate significant improvement in academic achievement and a close relationship between self-image and achievement. "Because the improved performance of the boys was matched by an improvement in feelings about themselves, the overt improvement cannot be attributed only to external stimulation or pressure. The real improvement in performance in the treated group and overall deterioration in the untreated group also increases the meaning and role of self-image in the therapy process" (*23*).

Although innate factors may set limits to learning ability, few people achieve anywhere near the innate capacity level. This premise led Brookover et al. (*3*) to investigate the degree to which self-concept could limit learning. They chose a sample of seventh-grade students from both high and low socioeconomic status. A Guttman-type scale was used for obtaining the educational and occupational aspirations and expectations. Evidence indicated that a larger percentages of these seventh graders aspired to go to college than *expected* to go. The mean self-concept of ability scores of those who aspired or expected to go to college were significantly higher than scores of the boys and girls who had lower aspirations or expectations. Oddly, the girls in this study had significantly higher mean self-concept of ability scores than the boys.

To find out if there are factors other than high intelligence that lead to the achievement of high grades, Coombs and Davies (*6*) set up a project with 186 college freshmen to determine the correlation between college grades and self-concepts formed prior to college admission. These researchers were not arguing that innate intelligence is unrelated to school achievement. Instead, they felt that the importance of intelligence may be overemphasized and that other factors may be neglected. They found evidence to show that (a) students with high precollege scholastic records have loftier conceptions of their scholastic ability, (b) they expect to obtain high college grades, and (c) they generally do.

Most social scientists doing research on the role of self-concept encounter evidence that social sys-

tems can affect self-concept, and, thus, role performance. A study (*5*) of Negro and white elementary children showed that those in segregated schools had less positive self-concepts and lower levels of aspiration than children in desegregated schools. As in other studies, those children that had more favorable self-concepts and higher aspirations had achieved higher academic ratings.

In schools where scholarship is devalued, students will tend to avoid the negative image of "bookworm" by studying less. In contrast, where educators and parents place a high value on scholastic achievement, the role performance of students will generally match what is expected of them.

Three steps have been suggested (*4*) in the handling of a student with a negative self-concept: (a) Trying to prevent the concept from becoming established, or—where such a goal seems improbable—establishing an atmosphere of mutual respect to prevent future inhibition of ability, (b) establishing oneself as a significant other person by recognizing and acknowledging something worthwhile in the student, and (c) encouraging exploration in socially acceptable ways.

Self-Concept and Vocational Choice

THE idea that occupational choice is the process of implementing self-concept began to bridge the gap between personality theory and vocational psychology nearly two decades ago. Since then, a number of principles have been established and are being used in vocational guidance programs. Perceptive investigators, however, believe there is a genuine need for new research approaches on patterns of career development and their antecedent and correlative conditions. This need is particularly urgent when one considers that the vocational fantasies, choices, and conflicts of youth are linked somehow with their attempts to deal with recognition, status, and self-esteem (*11*).

An individual chooses a particular occupation because he believes the roles he will play in the job will be consistent with his view of the kind of person he is. Thus, the occupation makes it possible for him to assume a role appropriate to the self-concept. Recognition of this principle has added depth and meaning to the work of vocational guidance (*27*).

Persons with high self-esteem are likely to choose occupations which they perceive as most likely to fulfill their needs in keeping with their self-perceived characteristics (*12*). Thus, they tend to reject those influences that might minimize their achievement. On the other hand, persons with low self-esteem are less likely to choose occupations that will implement need satisfaction. A study of 81 male college students not only gave credence to this principle, but also showed that self-esteem is positively related to the degree of similarity between self-concepts and occupational preferences (*20*).

Another study of 500 college students demonstrated that persons are in related fields because they have similar personality characteristics, similar needs, and manifest similar social adjustment patterns (*25*). Even though these students had the same common denominator (they all wanted to be teachers) they differed according to their chosen field—music, science, or physical education.

In what way are vocational choices made by people who are heterogeneous in ability, socioeconomic status, and the occupations they are preparing to enter or had entered? This question served as the basis for a research study in 1965 by Marr (*16*). Rather than study a person's vocational choice, which has in the past been the general approach, Marr preferred to consider the factors involved in making a vocational choice. The results indicated that making a vocational choice is difficult in the absence of a role model. More subjects who had made a vocational choice than those who had not made choices had had a father or father substitute whom they accepted. Furthermore, persons deciding upon an occupation early (while in high school) tended to be self-directing. It is possible, however, that once a person set an occupational goal, it was easier for him to have been self-directing. Deciding upon an occupation has been identified as a developmental task. Therefore, it can be expected that those who decide early do so because they are able to make their choices independently and effectively. Adolescents who have realistic and well-formulated self-concepts are ready early to find occupations suited to them and take their occupational place in the world.

Marr also found that subjects who were not self-directing had lower self-esteem scores than the other subjects. Also, lower self-esteem scores were found for subjects who were "ambivalent or lukewarm" about their chosen occupations or wanted to leave them.

Mothers' Aspirations for Children

QUITE frequently, the mother is a significant other person influencing the decisions of young people. Particularly in the low-income family, the mother seems to be the logical family member to promote family progress. Evidence of matricentrism (the mother as the center of the family) has been found among both Negro and white groups (*10*). It was also found that mothers' aspirations were higher than those of the fathers.

A study of low-income mothers in Maryland indicated that mothers were not satisfied with present conditions and they aspired to realistic goals which they felt would be attainable if some of their problems and blocks could be removed (*19*). Mothers commonly stated that they wanted their daughters to have "a happy marriage, a family, a home, and as much education as they could get." Most of the mothers expected their daughters to finish high school. In response to questions concerning educational and occupational aspirations for sons, the mothers mentioned high school completion and college attendance if possible; but their expectations were that they might finish high school. More mothers desired their sons to have a professional career.

Matricentrism, pertaining to career choice and planning, tends to be a lower class phenomenon. But a study of adult men to examine their occupational aspirations and expectations for themselves and their children showed that men in lower status occupations neither desired nor expected to move out of their low positions (*28*). A tendency was observed, however, for men to want their sons to have higher prestige occupations than theirs.

On the basis of at least two studies to date among Negro lower classes (*1, 2*), a measure of mothers' aspirations for their children shows a wide range of beliefs and values. Although most of the Negro parents in the studies—whatever their own achievement might have been—harbored high aspirations for their children, general social values appear to have less exclusive force in the lower class. It was felt that the high occupational aspirations expressed by many parents reflect a lack of understanding of the extent of preparation needed for prestige occupations.

One point that seems readily apparent is that we need further refinement in methods of measuring a mother's aspirations for her child so that the researcher could get a more accurate picture of what a particular mother knows about the educational requirements of the job aspired to. Such a refinement in research technique might very well lead to more effective guidance programs, which in turn could lead to more realistic aspirations and improved chances for fulfillment.

Conclusions

THE scope of the research effort needed to break the poverty cycle quite likely extends much beyond the program parameters discussed in this review. Yet enough sociological data have already been documented to show that a better understanding of self-concept can provide a solid base for further progress in our efforts to help children in impoverished families fit into our changing society.

A growing body of evidence indicates that child-rearing practices in lower classes differ from those commonly followed in middle class families. The root of the matter, therefore, is the family—particularly family interaction, structure, environment, and social participation. To better understand the occupational motivations and aspirations of children, a broader background of information is needed on such factors as child-rearing practices, mother-child communication, and vocational decision making.

All of the complex factors that have created lower educational and occupational goals among poverty classes should, of course, be examined and related. But even at this preliminary stage, it seems clear that some factors are more important than others. Indeed, the self-concept of both mother and child may rank close to the top among the more significant variables in occupational aspiration.

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EPIDEM (*Continued from page 13*)

of temperature and light upon a stage of *Alternaria's* life was incorporated into EPIDEM exactly as it was observed in the laboratory. All other information available was also employed.

Several phenomena, however, had been overlooked by experimenters. But in attempting to build a logical simulator we found that information about the phenomena was essential. The required experiments were often manageable, they were performed, and are reported here. For example, the speed with which a germinated spore reaches the sanctuary of the leaf interior by penetrating its epidermis, the washing of spores by rain, the fertility of conidiophores that had lost their spores, and the survival after drying of stalks, spores, and germinated spores—all were observed.

The simulator is, in fact, a computer program written in Fortran IV. Its composition, fungal stage by fungal stage, is described in detail for it may be a guide to similar analyses of other diseases.

Epidemics of *Alternaria* blight had been observed for many years at the Lockwood Farm near New Haven. Five years of diverse weather and disease severity were selected. Then the weather observations for those years were furnished to EPIDEM and a satisfactory mimicking of the real epidemics was performed by the simulator.

The tested simulator was then used to explore how influential were various characteristics of host and pathogen. For example, slowing sporulation seems to have little influence upon an epidemic, while sterilizing half the stalks decreases the final epidemic to less than a tenth.

Finally, the pathologic feedback in weather modification or climatic variety was explored with EPIDEM as a guide. It revealed, for example, the fear of daytime irrigation in Connecticut was a bugaboo, while dew in Israel was—as claimed by others—a true danger.

Early blight has been described as both a wet weather and a dry weather disease—often by the same man. By taking the life of the fugus step-by-step with the often opposing effects of weather, EPIDEM explains the apparent paradox. *Alternaria,* like people, likes a variety of weather in the right season.

P. E. Waggoner and J. G. Horsfall
Connecticut Agricultural Experiment Station, New Haven

A PROGRAM FOR OUTDOOR RECREATION RESEARCH

SEVEN years ago, the first issue of *Review* published a summary article about the first National Conference of Outdoor Recreation Research. A sense of urgency for a stronger, broader research program seemed to prevail at that meeting. A unit of play, it was noted, is almost as important as a unit of work. One speaker observed that although Federal recreation action programs spent $200 million annually, less than $500,000 was spent on recreation research. It was generally agreed that outdoor recreation research programs needed strengthening.

How has the picture changed during the intervening years? The same sense of urgency still prevails. The research effort is still modest—about one cent for every $3 of acquisition and capital improvement expenditure.

These facts—and others—are revealed in a recent report of a study conference conducted by the

National Academy of Sciences for the U.S. Department of the Interior, Bureau of Outdoor Recreation.[1]

The report views recreation as a social institution. Its purpose is to enhance human life by offering satisfaction and by enriching human capital. Recreation is no longer regarded as a form of indulgence having marginal status among the concerns of society. Instead, it carries comparable importance and priority with the social structures centered on production and consumption.

The study committee regards the report as an initial approach to research, as well as an invitation to universities, public and private agencies, and State and local governments for greater participation in the study of recreation problems.

Recommendations

TWELVE specific recommendations are offered:

1. *Apply new concepts that will broaden research programs beyond the present primary emphasis on managing recreation resources.* Without diminishing the importance of research on resource management, the study group urges support of new approaches to remedy present deficiencies in recreation-research programs. To broaden understanding of outdoor recreation as a social institution, research programs should be designed to attract social and behavioral scientists.

2. *Establish a program of vigorous experimentation on the social structures serving outdoor recreation.* The possibility of creating new facilities should be explored: Urban schools for total community use including recreation, urban parks adjacent to senior citizen apartments (to provide child care for working mothers), underground parking installations topped by recreation areas.

3. *Acquire a better understanding of the social and psychological forces that shape and sustain outdoor recreation programs.* Suggested areas: Analysis of satisfactions sought in recreational activities, diagnosis of abnormal behavior, relation between activities and their values, benefits to the external community. These problems are particularly suited to research by universities because they have the talents to implement such programs.

4. *Expand economic research on outdoor recreation, particularly models of economic demand.*

5. *Investigate the factors relating to the supply of recreational services.* These include the measures and standards needed to determine the quality of recreational services, the carrying capacity of a resource and the effects of use.

6. *Investigate the communication and information needs of outdoor recreation.*

7. *Establish a systems-research group on outdoor recreation as an aid to making better policy decisions.*

8. *Establish a university-based center for outdoor recreation research.* Although more than 100 institutions are now working on various aspects of outdoor recreation, there is no concentrated social and behaviorial science capability of sufficient scope to assure excellence and provide the proper focus on the many aspects of recreation problems.

9. *Broaden the function of the Research Division of the Bureau of Outdoor Recreation.* As the focal point for coordination and leadership in matters of recreation policy, BOR can contribute to the quality and relevance of the total research effort of Federal agencies in this area.

10. *Create a research advisory board to monitor on-going research programs, plan alternative or additional programs, and set priorities.*

11. *Establish an interagency committee on recreation research under the aegis of the Federal Council for Science and Technology.*

12. *Explore the need for and feasibility of establishing a national institute of recreation research.* Functions of the institute would include: Conducting in-house and extramural research under contracts and grants; recruiting and training professional manpower; providing leadership in program planning, coordination, and policy guidance; managing budget and program support; and administering information and data services.

Concepts and Economics of Recreation

TWO of the most significant contributions of the study group report, in the opinion of *Review*, concern the changing concepts of recreation and the magnitude of the financial and human resources involved.

In the first place, our concepts of recreation are markedly different from what they were a genera-

[1] "A Program for Outdoor Recreation Research," Pub. No. 1727, National Academy of Sciences, Washington, D.C. 1969.

tion ago. "The contrast of recreation as inherently pleasurable and work as displeasure may be dismissed out of hand. The seven dwarfs 'whistle while they work', but the young debutante suffers through the cotillion. Fishing is work for one and play for another." [2]

The report suggests that the content of recreation can be analyzed in terms of a drama in which the players symbolically deal with a life problem. In terms of social problems of crowded urban environments, therefore, the crucial question may be to ascertain the meaning of recreation for these populations. Thus, the relevance of recreation research to the problems of the inner city becomes sharply apparent.

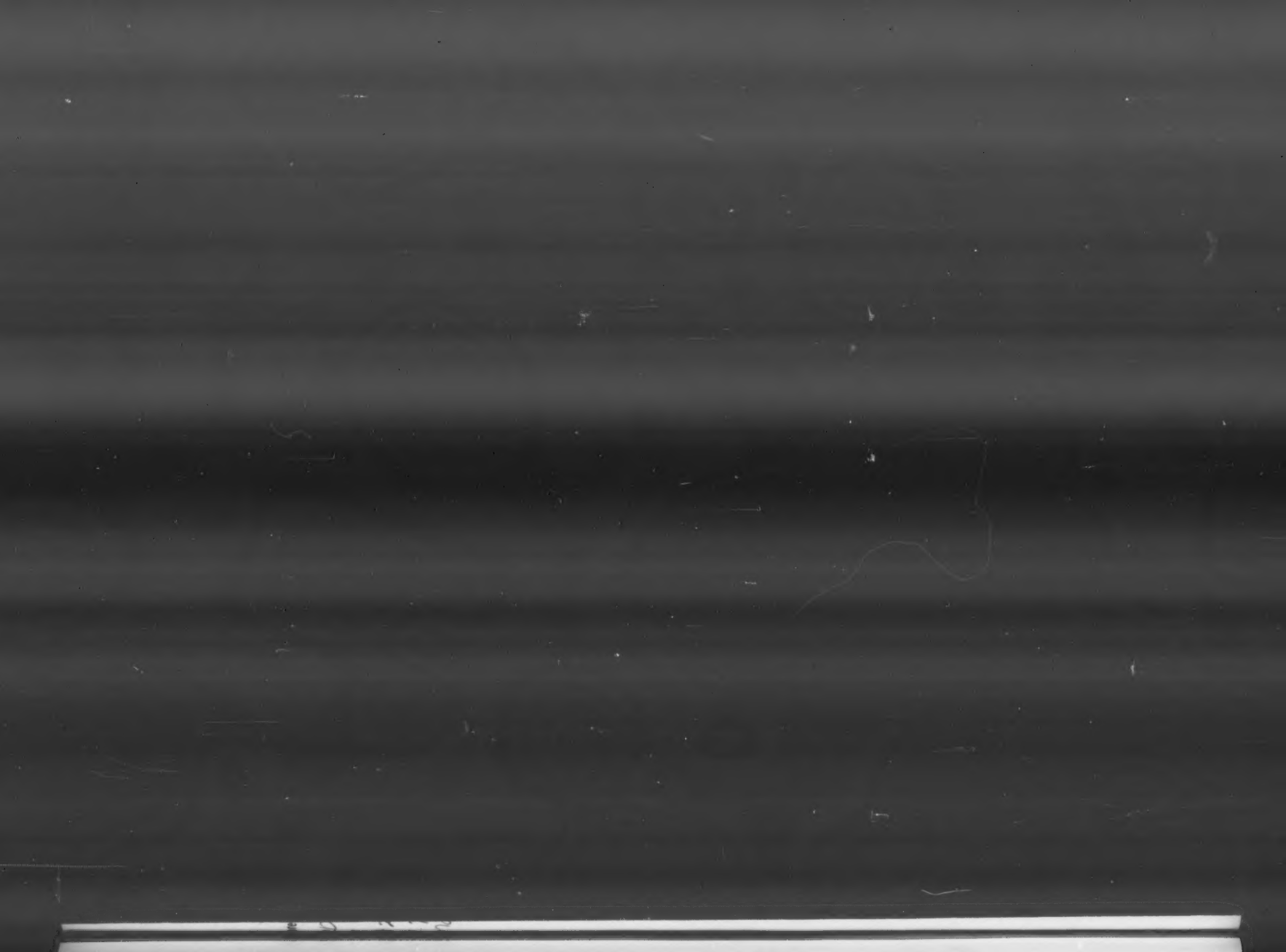
More than 80 Federal agencies, as well as the 50 States, and some 4,000 local, metropolitan, and regional authorities now bear responsibility for providing recreational services. The heavy demands on these services are rightfully a matter of public concern because of the heavy involvement of public institutions in the allocation of recreational resources. Unlike a market situation where required adjustments are carried out by the private sector, shifts in demand affecting recreational resources clearly become an obligation of public agencies. As might be expected, solutions to the many problems involved must await the application of appropriate research programs.

[2] From Appendix A of the report, "Recreation as Social Action," by Samuel Z. Klausner.

THE AUTHORS

LEO POLOPOLUS ("Synthetics and Substitute Foods: Domestic and International Aspects") is professor of agricultural economics and Assistant Dean of the Graduate School, University of Florida. He holds a B.S. degree from the University of California at Davis and the Ph. D. degree from the University of California at Berkeley. Dr. Polopolus was previously employed as Director of the Economic Research Department of the Florida Citrus Commission and as Associate Professor of agricultural economics at Louisiana State University.

SARAH M. SHOFFNER ("Self Concept—Its Role in Breaking the Poverty Cycle") is a research instructor in child development and family relations, School of Home Economics, University of North Carolina at Greensboro. She received both the B.S. (1962) and M.S. (1964) degrees from the University of North Carolina at Greensboro. For 3 years, she was coinvestigator under a research grant from the Office of Education, U.S. Department of Health, Education, and Welfare to compare programed instruction and the demonstration method of teaching. Mrs. Shoffner coauthored the research materials developed for the project and published them as junior and senior high school home economics texts.

U.S. GOVERNMENT PRINTING OFFICE: 1970 O—389-694

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